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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

TERM: SEMESTER FINAL EXAMINATION

WINTER SEMESTER: 2022-2023

COURSE NO.: Chem – 4153

TIME: 3.0 Hours

COURSE TITLE: Chemistry I

FULL MARKS: 150

There are 7 (Seven) questions. Answer any 6 (Six) questions. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO in the brackets. Symbols convey their usual meanings. Assume reasonable values for any missing data.

1. (a) State and explain different forms of Henry's law. Discuss the limitation and application of Henry's law. (10²/₃)
(CO1)
(PO1)
- (b) What do you understand by absorption coefficient? A saturated solution of air in water contains 12.5 mL CO₂ (at N.T.P) in 50 g water. The partial pressure of CO₂ in air is 300mm (Hg) Calculate the absorption coefficient of CO₂ in water. (6)
(CO1)
(PO1)
- (c) Define boiling point of a liquid relating to its vapour pressure. Derive a mathematical expression correlating molecular weight of the solute with the elevation of boiling point of solution. (8¹/₂)
(CO2)
(PO2)
2. (a) Describe the fundamental particles of an atom. Electrons and protons are the essential fundamental particles of all atoms but neutron is not, explain it. (10²/₃)
Derive a mathematical expression for the energy of an electron revolving around the nucleolus in different energy level. (CO1)
(PO1)
- (b) Calculate the velocity and energy of an electron revolving around the nucleus residing in the ground energy level of hydrogen atom. (6)
(CO1)
(PO1)
- (c) Discuss the main cause of heat change in a chemical reaction. Derive a mathematical relation which expresses the effect of temperature on heat of reaction. (8¹/₃)
(CO2)
(PO2)
3. (a) How many two and three phase equilibria are there in the phase diagram of sulfur? Draw the phase diagram of sulfur and describe these equilibria. (10²/₃)
(CO1)
(PO1)
- (b) What do you understand by a chemical bond? Discuss the main cause of chemical bond formation. Explain the covalent character of ionic bond and ionic character of covalent bond. (6)
(CO1)
(PO1)
- (c) Describe the overall process of experimental determination of heat of combustion with necessary correction. (8¹/₃)
Describe term water equivalent of calorimeter. Why it is necessary to include in the calculation of experimental determination of heat of combustion? (CO2)
(PO2)

4. (a) Define covalent bond. Discuss the different characteristic properties of covalent bond. Describe octet rule and deviation of octet rule in covalent bond formation with suitable examples. $(8\frac{1}{3})$
(CO1)
(PO1)
- (b) Describe the wave and particle nature of an electron with mathematical expression. Show by calculation that a bigger particle like a marble does not have wave nature but a smaller particle like electron may have. $(8\frac{1}{3})$
(CO1)
(PO1)
- (c) Describe how chemical energy is being converted into electrical energy. Discuss the chronological development of theories of electrolysis. $(8\frac{1}{3})$
(CO2)
(PO2)
- 5 (a) Discuss the basic characteristic points of the definition of a true solution. A solution is prepared by dissolving 10.6g Na_2CO_3 in 75g water. At 27°C the density of the solution is 1.05g/mL . Calculate the normality and molarity of the solution. $(8\frac{1}{3})$
(CO1)
(PO1)
- (b) State law of mass action. Derive a mathematical expression for the equilibrium constant K_c of the following reaction: $(8\frac{1}{3})$
$$2\text{NH}_3 \rightleftharpoons \text{N}_2 + 3\text{H}_2$$

(CO1)
(PO1)
At 327°C the K_p value for the above reaction is 4.0×10^{-4} . Calculate the value of K_c for this reaction at the same temperature.
- (c) Classify electrical conductors into different classes with examples. Describe the necessary arrangements by which electrical energy can be converted into chemical energy. Write the reactions involved in the conversion of electrical energy into chemical energy. $(8\frac{1}{3})$
(CO2)
(PO2)
- 6 (a) What do you understand by rate of a reaction? Discuss the effect of different factors on the rate of a reaction. $(8\frac{1}{3})$
(CO1)
(PO1)
- (b) Derive a mathematical expression for the rate constant of a first order reaction. In a first order reaction the time required to reduce the concentration of the reactant from its initial value 0.5mole dm^{-3} to a value 0.2 mole dm^{-3} is 1.5min. Calculate the rate constant of the reaction. $(8\frac{1}{3})$
(CO1)
(PO1)
- (c) Illustrate the terms specific conductance, equivalent conductance and molar conductance of electrolytic solution. What do you understand by cell constant of an electro-chemical cell? $(8\frac{1}{3})$
(CO2)
(PO2)
- 7 (a) What is a coordinate covalent bond? How is a coordinate covalent bond formed? Explain the bonds involved in NH_4^+ . $(8\frac{1}{3})$
(CO1)
(PO1)
Write a note on half life value of a chemical reaction.
- (b) Illustrate the terms heat capacity, specific heat capacity and molar heat capacity. By derivation show that $C_p - C_v = R$. Explain why $C_p > C_v$ in the case gaseous substance. What will be difference in case of solid substance? $(8\frac{1}{3})$
(CO1)
(PO1)
- (c) Determine the charge of an electron from Faraday's laws of electrolysis. Discuss the effect of dilution on the equivalent conductance of different types of electrolytic solution with the help of diagram. $(8\frac{1}{3})$
(CO2)
(PO2)
Describe a method by which equivalent conductance of weak electrolytes at infinite dilution is determined.